

Sketching for Engineers



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Introduction

Sketching is a form of communication engineers frequently encounter. The light bulb flickers, an idea forms, and a sketch is born. A **sketch** is described as a rough drawing, general outline. Sketches are looser and freer than a formal drawing. Sketches are conceptual, creative, and rendered quickly, so accuracy isn't important or even possible some of the time.

So, a few questions:

Can you sketch?

Can you sketch quickly and in a way that makes sense?

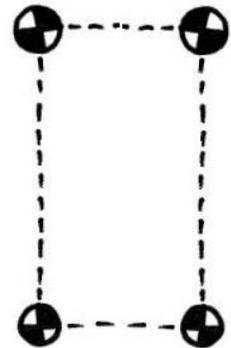
Does your ability to draw aid your communication or detract from it?

Can someone look at your drawings and know exactly what you are thinking?

Do you have to apologize for your drawings?

Let's try to fix that.

This course is an introduction to engineers who want to be able to sketch their thoughts on paper in a quick, easy way. **This is not a drafting class; you don't need a straightedge or ruler.** This course is part art class, part engineering school, and part physical training. It's not precise, and it's not accurate. That's tough for some engineers to process, so you may have to open your mind a bit to take this course.



Yes, you will need paper and pen. Yes, you should actually draw pictures. And when finished, you will have the basic tools to frame engineering work into context with a quick sketch. However, it takes time and practice to develop your skills, so don't set your expectations too high right away. Drawing is more than knowledge; it's both mental and physical training.

I've attempted to cover the fundamentals here and boil it down to a minimum. This isn't a comprehensive drawing class, but it will get you going. Hopefully, you will go far beyond and surpass the content presented here.

Sketching as an Engineer: Why?

When it comes to being an engineer, much of the work is divided into two phases:

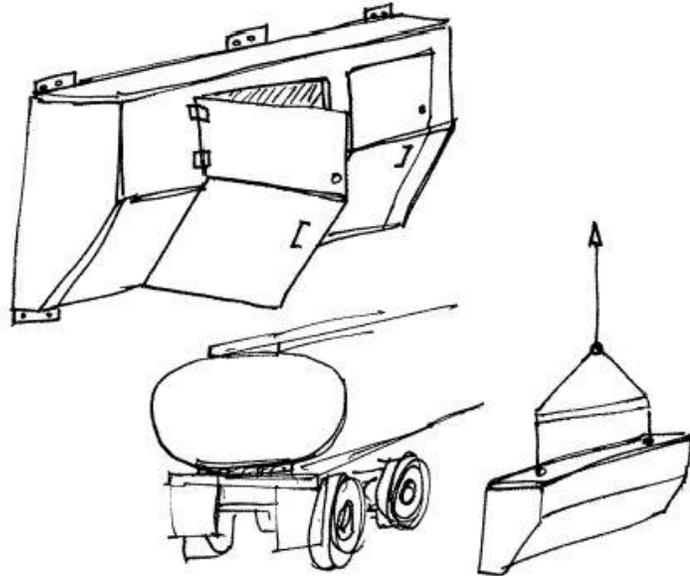
1. Solving technical problems, and
2. Communicating solutions

Solving problems takes design, analysis, research, testing, iteration, calculations, etc. Communicating solutions demands exchanging ideas, proposals, drawings, specifications, and the myriad of other details required to complete a project. Sketching finds its way into both of these phases. Yes, sketching can be

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avoided with the many digital software platforms available, but the ability to turn your thoughts into a picture in a few seconds is a golden ticket in engineering communication.

Over time, engineering has changed. The advent of the digital age has also impacted engineering in a major way. One specific example of this is the loss of skill engineers used to have for pencil-in-hand artistry. There was a time when being able to create accurate pencil-and-paper drawings was a key skill for both engineers and mechanical designers. This aspect of the field has almost entirely disappeared. Software and computers add great efficiency and ability to the modern engineer, but at the cost of other things going by the wayside.



This said, it is still beneficial to be able to sketch. It helps you understand things, and it helps other people understand you. Sketching opens a dialogue that can generate further ideas and encourages creativity, both huge assets in engineering.

No one, as far as I know anyway, was born with innate drawing talent. It's a skill that is learned. And you can learn it. "I'm not artistic" you might say. Or, "I can't draw" or "I'm not creative". You might be right, but you CAN learn new things and sketching is one of them. Give it a try; you might be surprised.

Train Your Brain

Drawing begins with your cognitive ability to do at least one of two things:

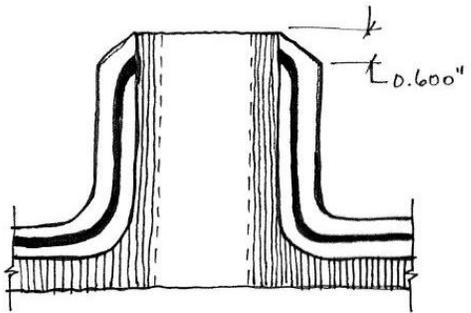
- a. Visually analyze an object, identify features, and duplicate them via mechanical motion onto paper.
- b. Visualize a new concept in your brain and turn it into a sketch on paper.

Engineers do both of these things. For example, say you are called upon to design a railing for an existing stairway. You visit the site and see the stairs. You know what the stairs look like. Back at the office, you recall the detailed features and draw the stairway on paper. Then, you add your new railing concept to the drawing, which is directly from your imagination.



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Sometimes you need to draw something that you can see. Other times, you need to draw something that only exists in your brain. Either way, you need to be able to analyze and see the details. The best way to practice this is drawing lots of things. You will begin to understand them more clearly when you have to mentally break them down into segments (i.e., lines). This mental observation is as important as the physical motions it takes to draw.



Physical muscle memory is required to develop consistent drawing skills. Also, good posture makes a difference while drawing. Sit up straight or try drawing while standing up and see how your sketches change.

Sketching Materials

When starting to learn to sketch, don't use expensive paper or notebooks. That only adds economic pressure on you to draw well, so you don't waste your investment. Rather, find scratch paper of any sort, a thin stack of regular old copy paper, a napkin, or an envelope from the mail. Remember: great ideas only come from the back of the napkin. Don't bother with the front.

I prefer to draw with a pencil (non-mechanical) or fine felt pens. Ballpoint doesn't work as well for me. You may find other mediums you like better: mechanical (graphite) pencil, Sharpie, fountain pen, colored pencil. Obviously, pencils are erasable and may be more attractive to beginners. However, I recommend not erasing at all when sketching. Use every line as training. Find what works best for you and use it, as long as it's convenient and readily available. You don't want to be at a critical meeting with a high-profile client, only to find out you can't draw because you left your expensive custom pen at the office. Practice with different things.

Contrary to popular belief, you don't need fancy pens or paper to draw well. But, if you draw well, you might begin to like fancy pens and paper. Got it?

In this course, we'll focus on drawing with paper. However, keep in mind drawing on a whiteboard on the wall is a lot different. Your arm will be basically parallel with gravity, not perpendicular to it. The same methods apply, but you might notice it is easier to draw one way or the other. For that matter, if you still use a chalkboard, you will notice that is even different because you have to apply more pressure than a dry erase marker. Again, practice with different things. Of course, you can sketch on anything. Try odd materials, just for fun: paper bags, business cards, wood, steel, your colleague's timecard, etc.

Scale

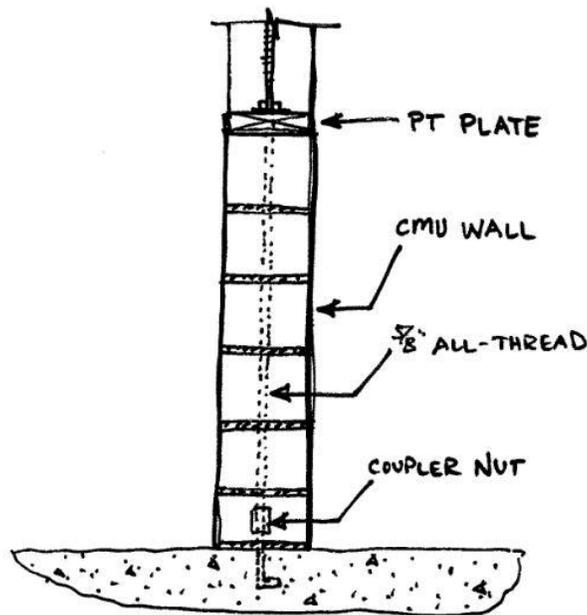
Sketch size is, perhaps, a debatable point whether to discuss in this course. Clearly, you want your sketch to fit on your medium, whether that is a whiteboard, 8.5x11 paper, notebook, etc. It's more relevant to consider drawing big enough, rather than drawing too small. If you have a large drawing space, don't draw too small. Scale it up and expand. There's no reason to cram a detailed sketch into a 4" x 4" area when you have an entire whiteboard to explain an idea. An easy way to practice this concept is to visualize how large you want the finished sketch to be BEFORE you begin drawing. Your brain will calibrate as you get better at this. Again, this isn't drafting. You don't have to identify the scale as 50:1 or 1:2. Just draw.

Hint: start by drawing the large features first, then follow with the small details. If you start with a small detail, your sketch will grow or shrink more than you want.

Basic Features: Text

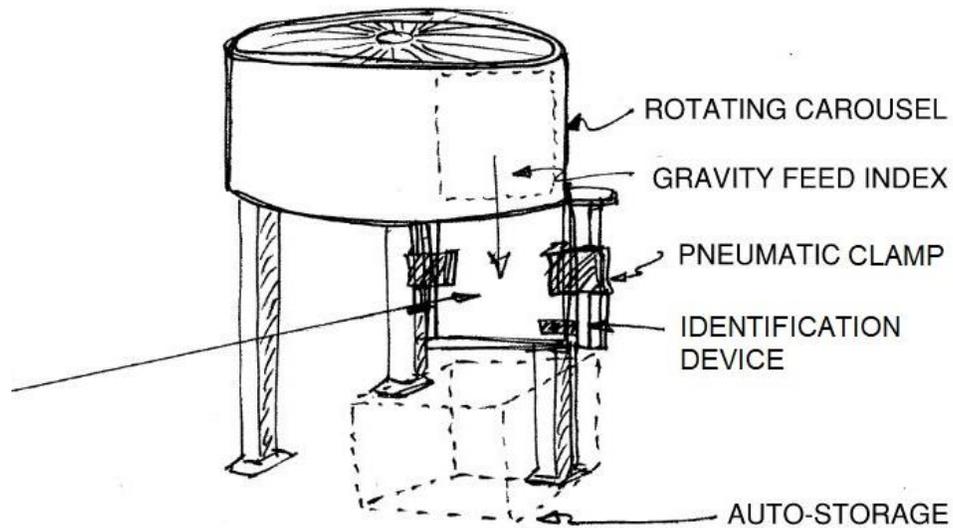
Let's begin basic features with text. Drafting class carries over here, with precise lettering required for mechanical drawings. Feel free to use similar lettering for sketches, or develop your own font. I use block capitals for almost everything. It's important that your sketch audience can easily read your writing. Don't take it personal if you, like me, need some practice.

ABCDEFGHIJKLMNOPQRSTUVWXYZ
 0123456789



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If my own handwriting is not sufficient (as it often isn't), I scan my sketch and add text using software, such as Bluebeam Revu, which adds a much cleaner look and a presentable rendering:



Basic Features: Lines & Shapes

The engineer in you may prevent you from sketching well. You have probably been trained in drafting, where every line is precise, intentional, and finite. To sketch, however, you must resist the temptation to make it perfect. It's much looser and more creative than drafting. Get used to it.

Let's move onto lines. Practice drawing lines while keeping your wrist straight and draw with your whole arm, not just your hand. Make smooth motions in a left-to-right (or reverse if you are left-handed) pattern. It's much easier to make straight lines this way the up and down, so turn your paper if you need a vertical line. Tip: use your little finger as a support while you draw.

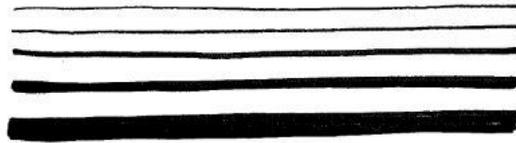
Avoid making "sketchy" lines. They create indistinct features. Strive for a clean line for each individual aspect.



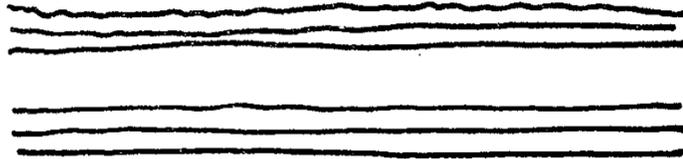
Depending on your writing utensil, your lines will vary in thickness. I use Staedtler pens (made in Germany) that vary from 0.1 mm to 1.2mm thick and create very clean lines. Even with a pencil, you can vary line

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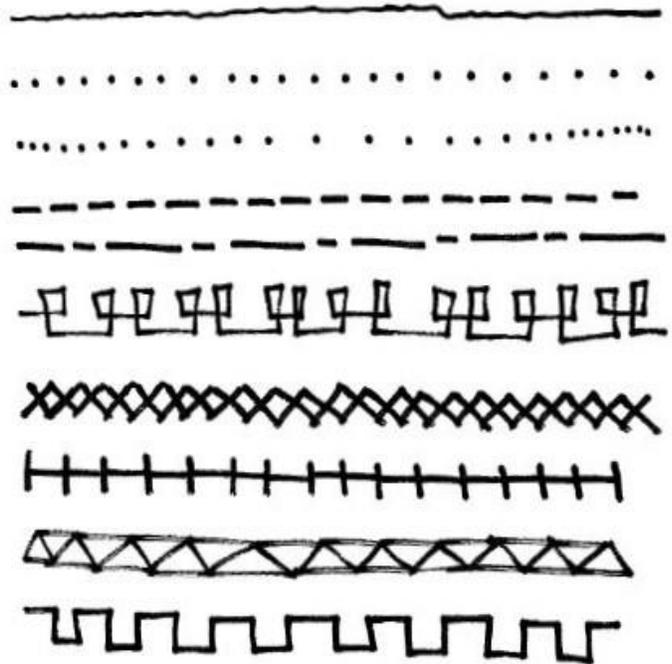
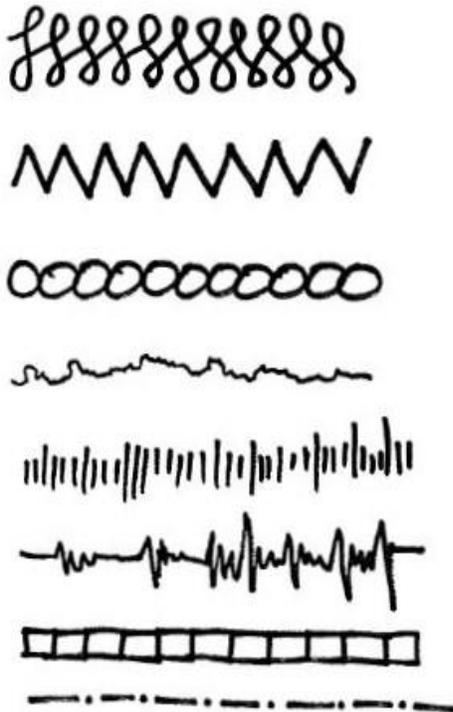
thickness by pushing harder. This variable helps when you want to draw attention to an outline or feature by making it thicker.



Now add some texture your lines. Make them a little wavy and have the ends cross at corners, which adds a different look to your sketch. I know, this is hard for some to do. However, you'll see how this look will soon add a lot to your drawings.

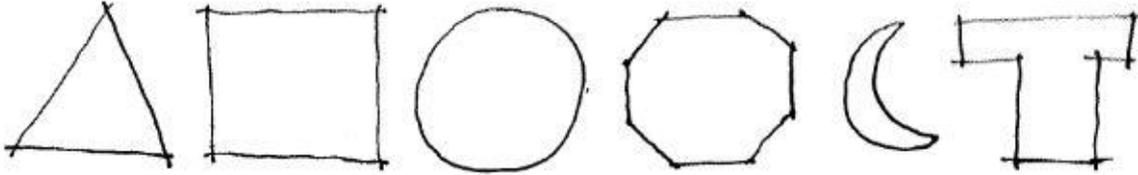


Try some patterns now. Practice with straight lines and add random designs for variety.

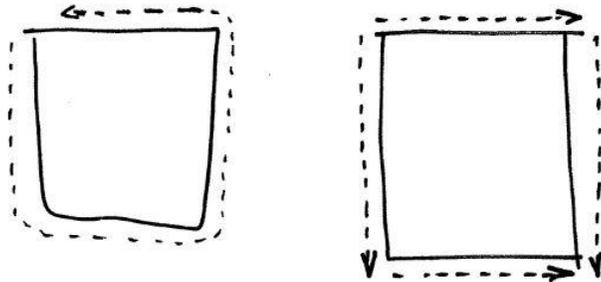


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Now, use simple lines to create basic shapes. The ability to identify and duplicate common shapes is one you probably honed in kindergarten, but it's still useful and definitely important.



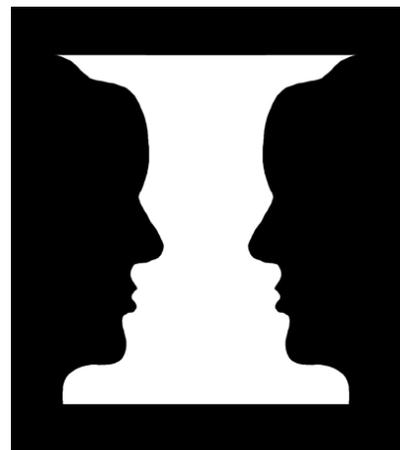
Make sure your shapes are made from individual lines, rather than continuous (unless it's an arc or circular). For example, make a square out of four distinct lines and lift your pen after each instead of one sweeping figure. Overlap the corners a little bit, too.



Begin to combine basic shapes into complex outlines, such as a cityscape. An important feature at this point is to identify the difference between **positive space** and **negative space**. Understanding the difference helps determine the composition of a sketch.

Positive space is the subject or area of interest in a sketch. Negative space is the area around the subject or area of interest. For example, this common illusion image demonstrates the concept very well. If you see a vase, you are placing the white vase as the subject, and therefore the positive space, with the black background as negative space. If you see faces, however, the white background is negative space.

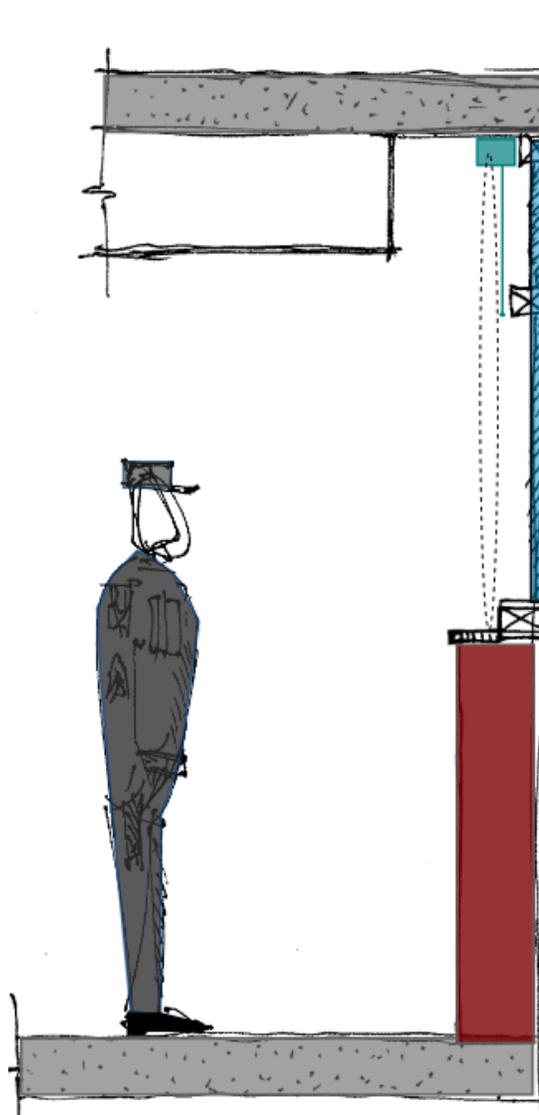
This concept may be less important than other forms of art, but it nonetheless helps to think about what your subject is and isn't, and how it will appear on paper.



Basic Features: Color

Regarding color, I recommend staying within the monochromatic realm. As an engineer, I figure if I can't convey a concept in one color, I'm not communicating it well enough.

The caveat to this is adding color post-sketch to make a presentable image, which is most useful when capturing attention. A splash of color makes even the most boring PowerPoint a bit more tolerable. For example, here is a sketch with added color using software:

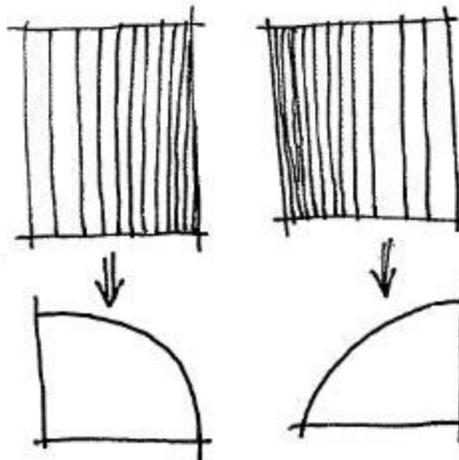


Basic Features: Texture

Hatching and texture are very easy ways to add depth and draw attention to an object in a sketch. For example, when there are adjacent parts, hatching highlights individual parts that might otherwise blend in. Hatched areas also add character when highlighting shadows. Start by drawing close, parallel lines going in only one direction. Then, add a second or third set in opposite or diagonal ways:

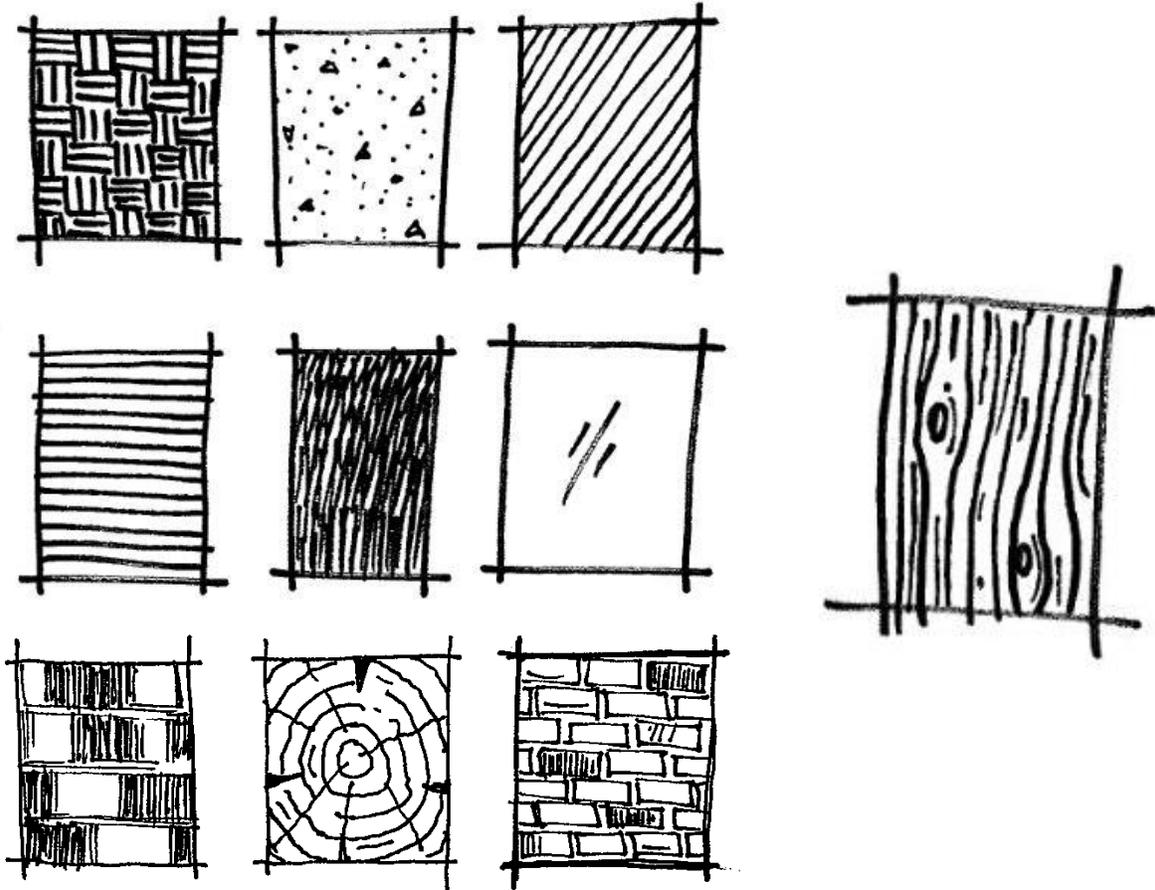


Hatching is an easy way to show depth, such as this plan view of a curved part, where the steepest part is darker than the flatter top:



Now, make some boxes and fill them by testing out various hatching patterns which represent soil, concrete, wood, water, etc. Texture adds a lot to a sketch and helps identify different materials. For example, soil can be represented by the three vertical/horizontal line pattern. Concrete is a mix of dots and small irregular shapes (aggregate). Glass is simple to identify with a few small parallel lines. Wood is a little more complex, and you should study the nearest 2x4 for a while if you aren't familiar with grain patterns.

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While there are common sketch methods for different materials, you are not bounded by any rules when sketching. It's art, not science. Make up some new textures that fit your concept, keeping in mind it still should be identifiable to your audience.

Perspective

Perspective, all too often, is the drawing aspect that causes the most fear and repulsion by attempting artists. It seems complex and intimidating, and to some degree, it is.

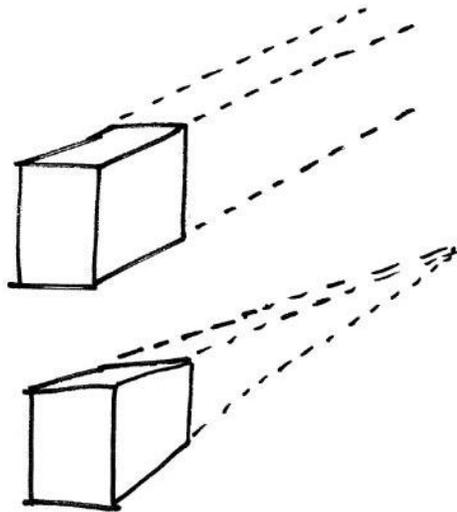
Here's the good news: you don't have to draw with perspective to communicate your point. It certainly adds much benefit and realism to your sketch, but many engineering applications can be conveyed in 2D or even 3D with no perspective.

What does perspective mean? **Perspective** is the phenomena that objects get smaller the further away they are from your point of view, which is technically called diminution. That is to say lines are not parallel, but

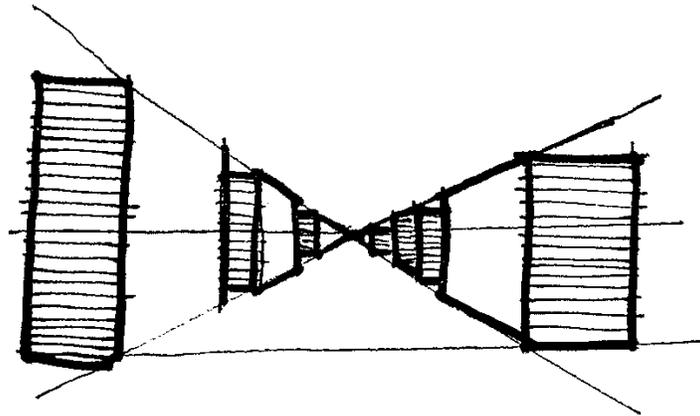
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rather converge. This image shows a 3D prism draw with and without perspective. Notice the one without has parallel lines, and the other doesn't. Anyone who has drafted isometric views of a part will recognize the parallel lines, while the diminishing part adds accuracy in a realistic view (which is how things actually look in the real world). Perspective is the way to show 3D object on a 2D paper.

Note: you can pick where you want the vanishing point to be. It usually ends up on the horizon (if there is one) or any other place in space. Play with drawing the same object and moving the vanishing point to see how the view changes.

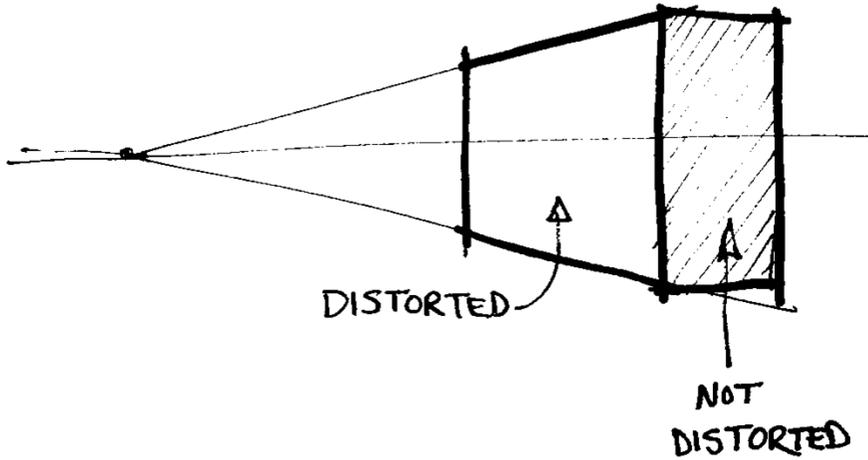


Here is a single vanishing point example:

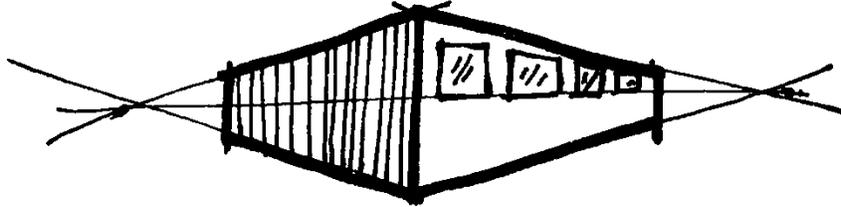


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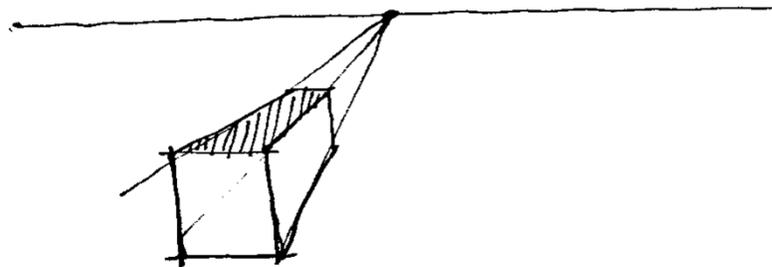
Also note that only the sides of the object become distorted with perspective with one vanishing point:



This sketch has two vanishing points:

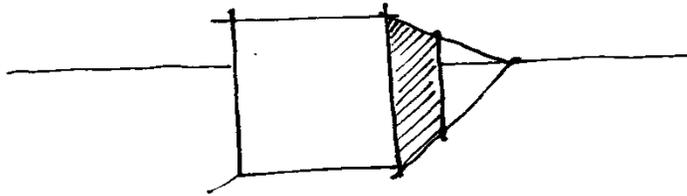


Now, notice that if the horizon is above an object, you can see the top side, but not the bottom:

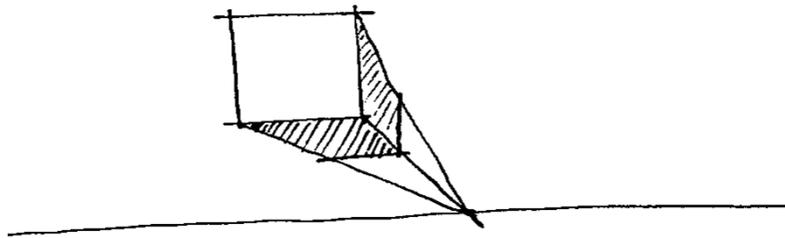


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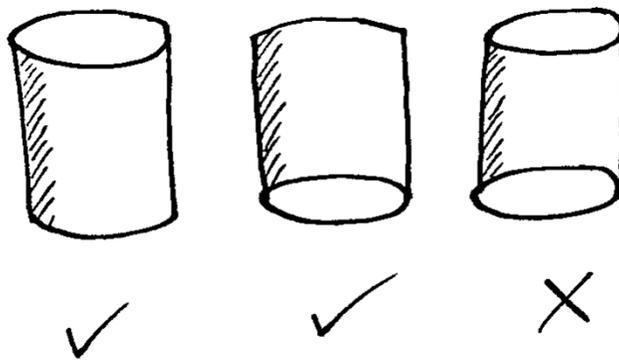
If the horizon is in the middle of the object, you can't see either the top or the bottom:



And if the horizon is below the object, you can see the bottom:

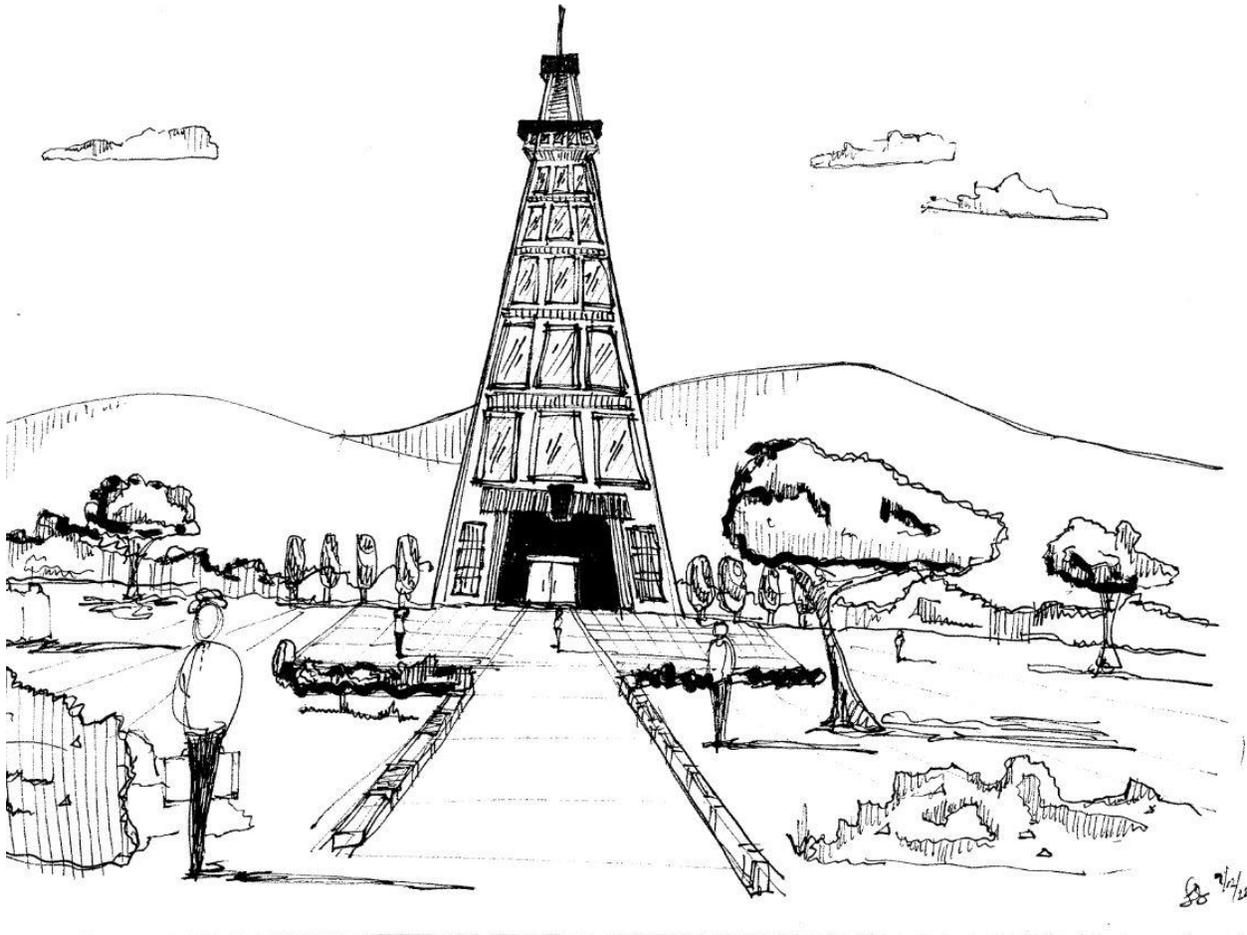


When drawing a 3D object, such as this cylinder, make sure you either see the top or bottom, not both. If this doesn't make sense, grab a coffee can and take a look for yourself.



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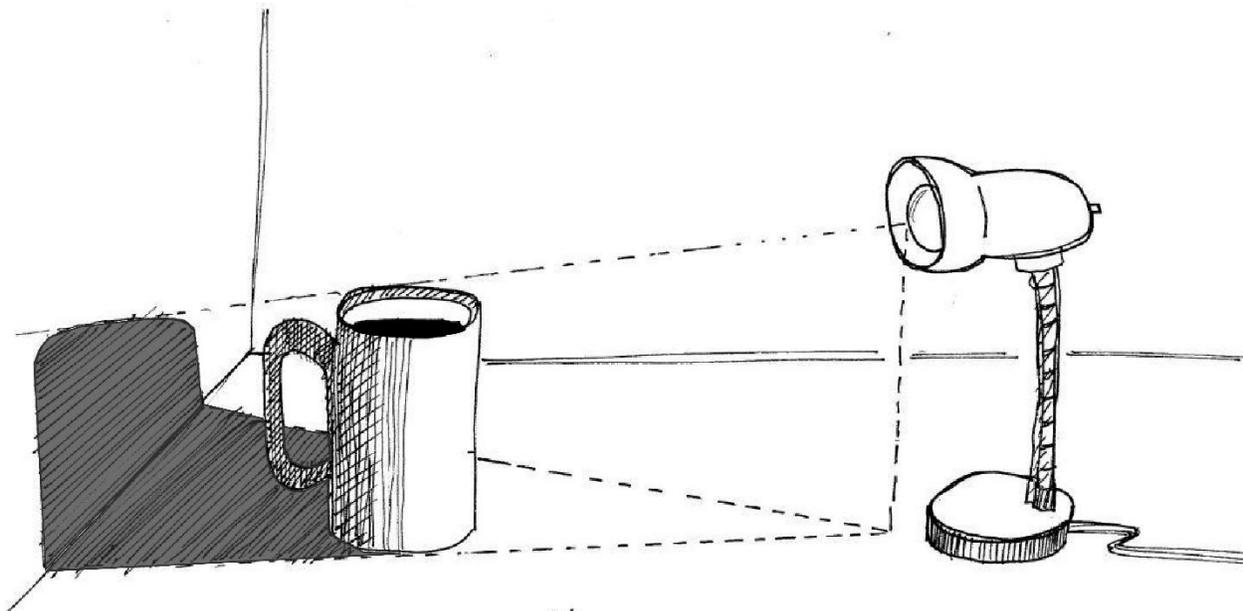
Here is a scene that shows a two-point perspective: one vanishing into the sky (the building gets smaller at the top), and one on the horizon (the walkway gets smaller in the distance):



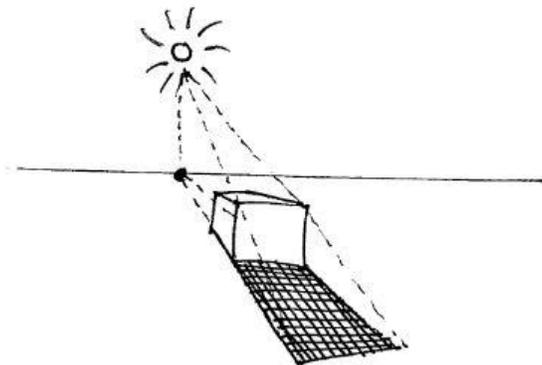
Shadows

Shadows, while all around us, can be difficult to sketch without carefully assessing the light sources and angles. You may not need to include shadows in your sketches, but they definitely add realism and depth to a drawing. I recommend at least adding shadows when drawing large outdoor engineering objects, such as buildings or other structures.

The best way to draw shadows is to first draw the light source as a point in space then following the light to the object of your sketch. See this example, where the light casts a shadow on two planes, the wall and the floor, which also shows perspective as the shadow is wider on the wall than the mug. You have to follow the light in both planes to get a proper shadow.



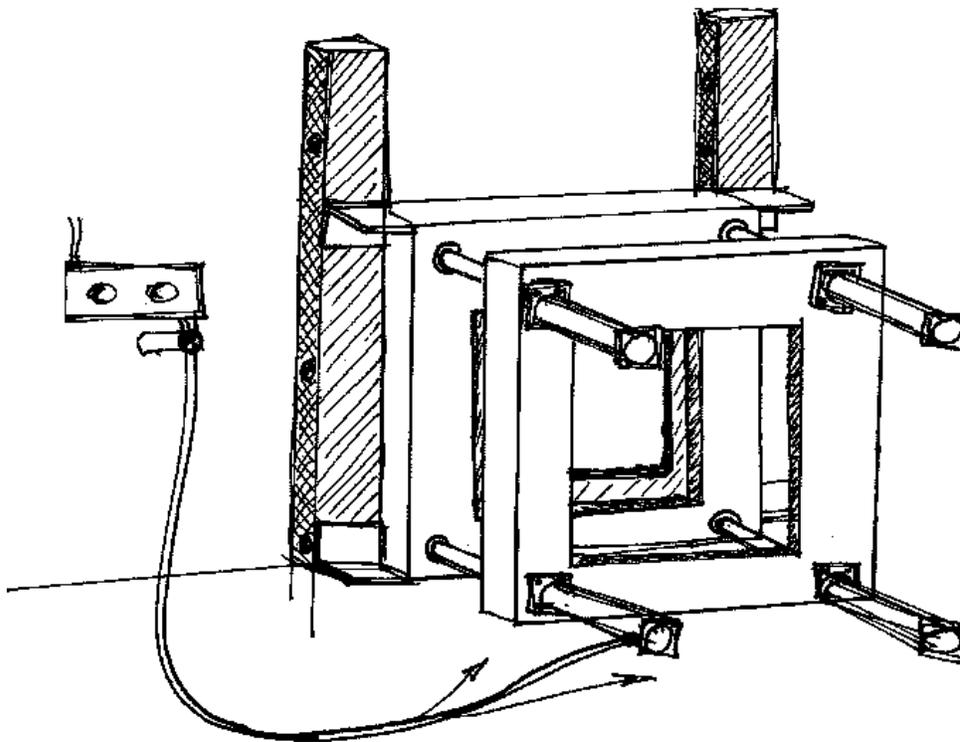
The same idea goes for outside objects in perspective as well. You may want to start looking at shadows a little more closely from now on.



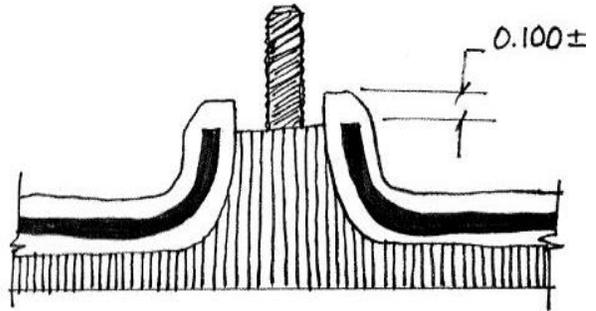
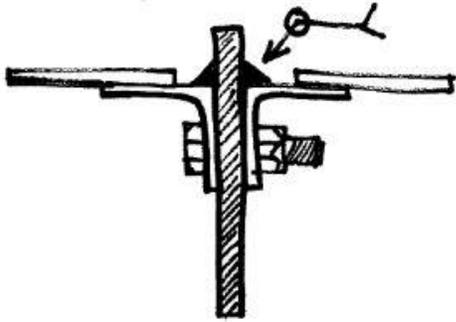
Put it All Together

Now you have the tools to produce a complete sketch, so go ahead and give it a shot. Begin with simple objects and work your way up toward more complexity. Mostly, have fun, and don't get upset or discouraged. Experiment and try different things; if it works, keep doing it. If not, try something different. Just keep at it.

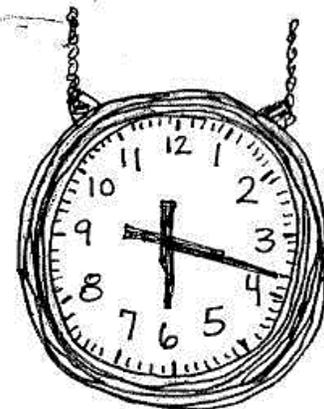
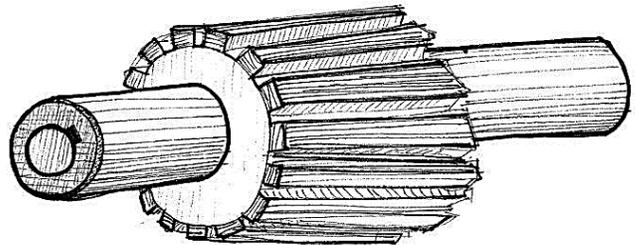
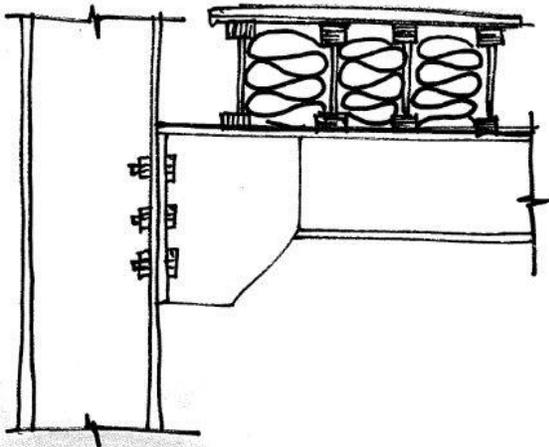
Here are a few random sketches to demonstrate a variety of objects and ideas, some of which are obviously more practical than others. Feel free to analyze these and use them for reference.



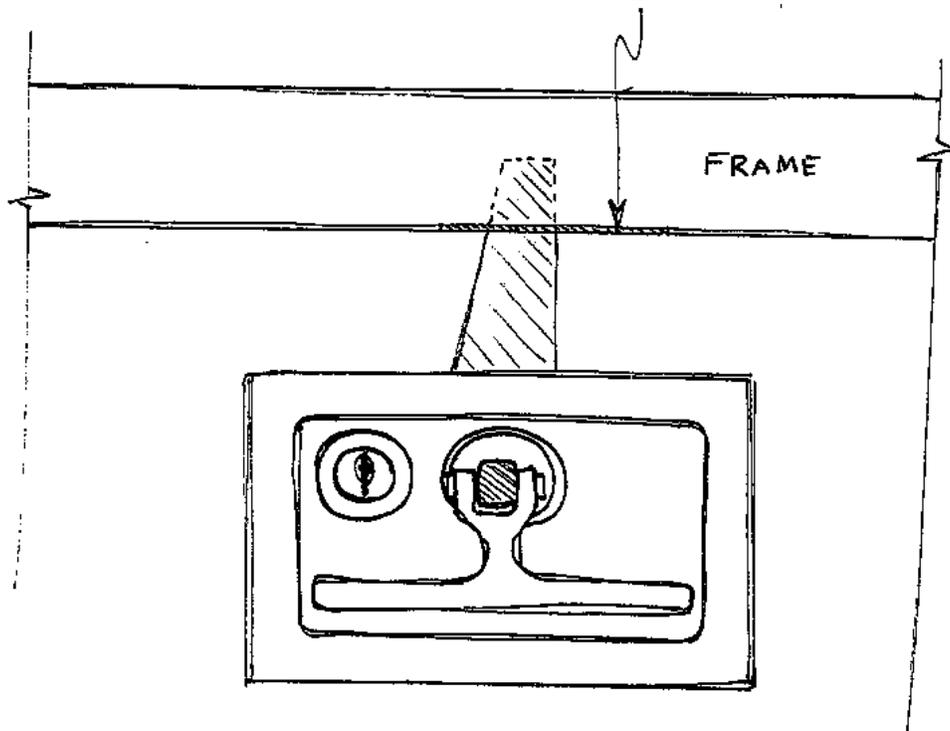
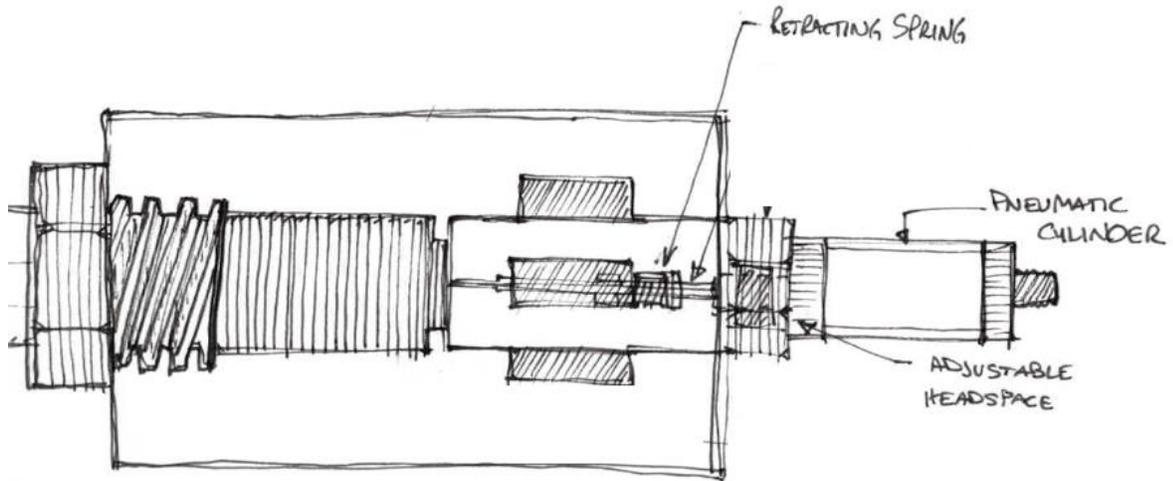
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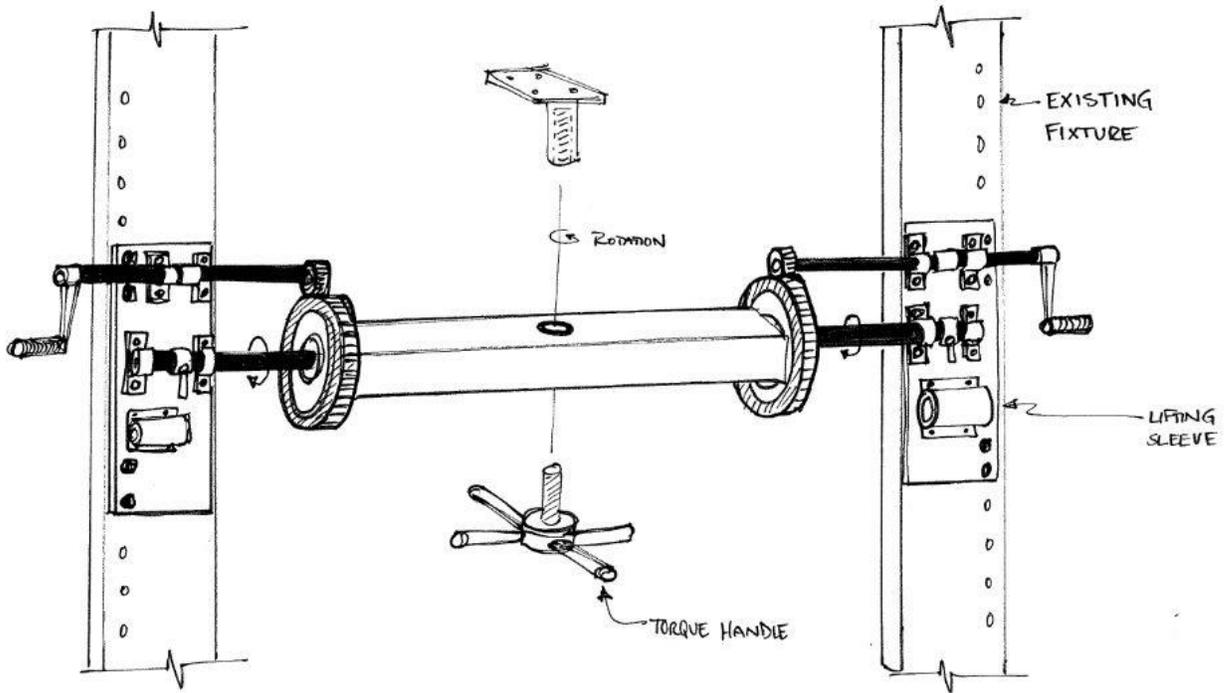
RAISED BOSSES



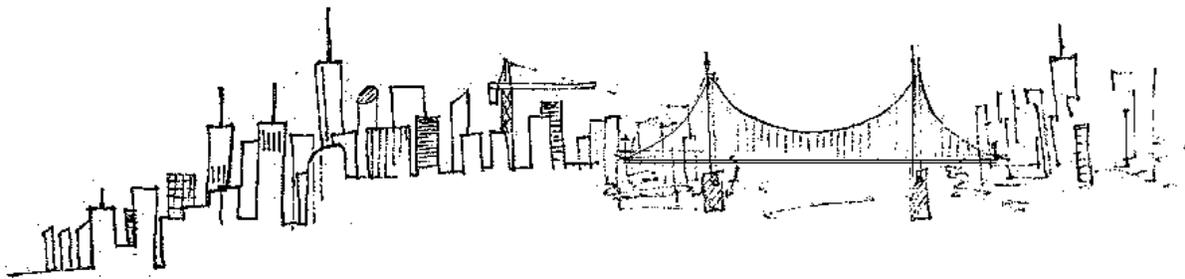
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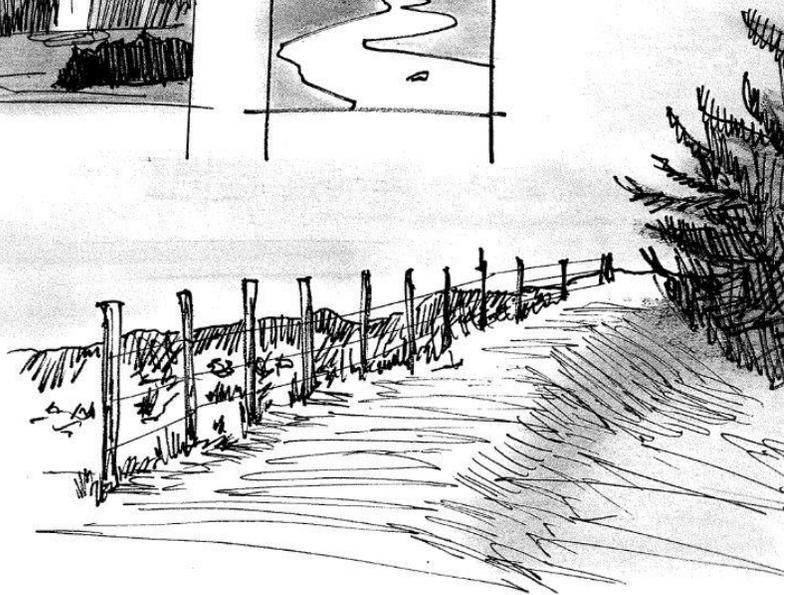
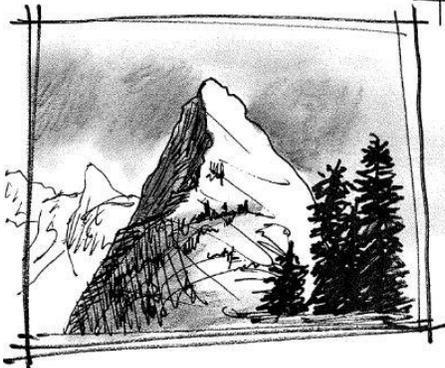
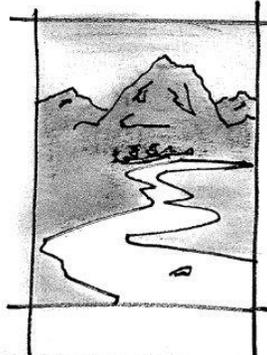
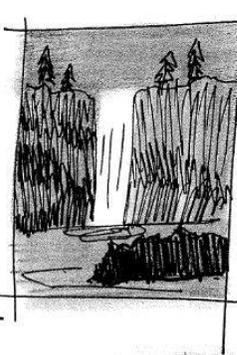
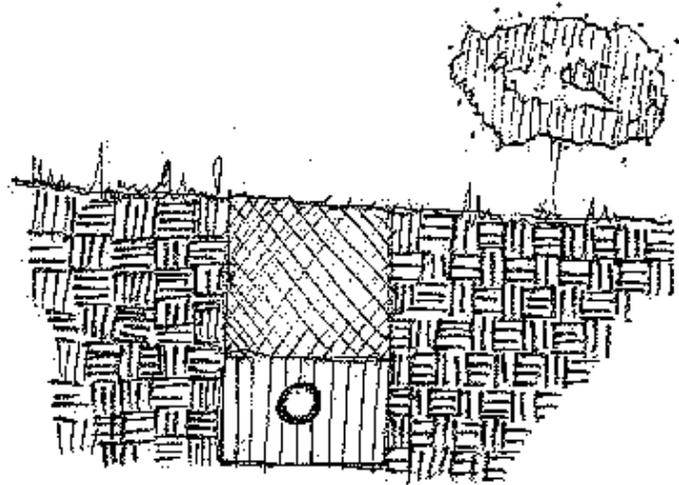
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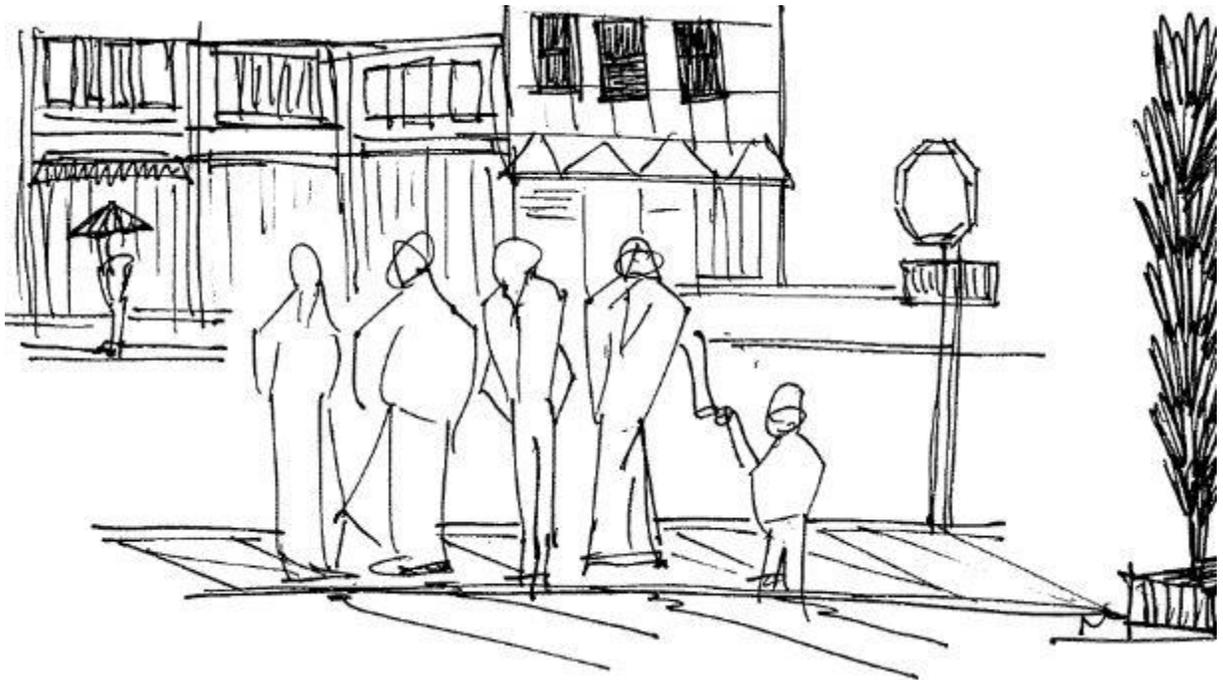
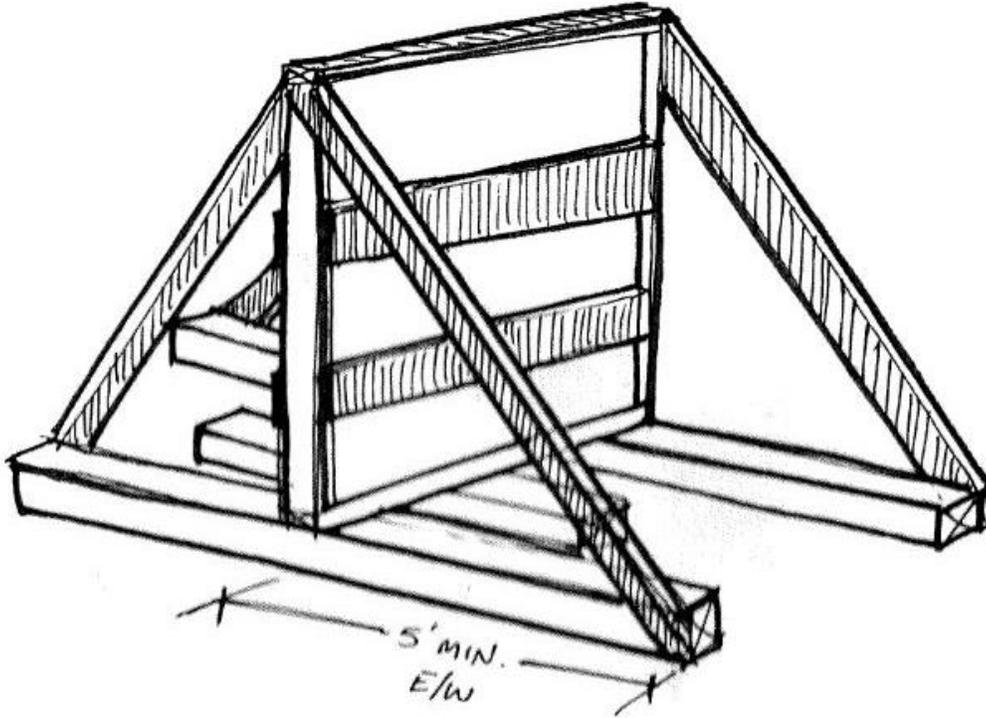
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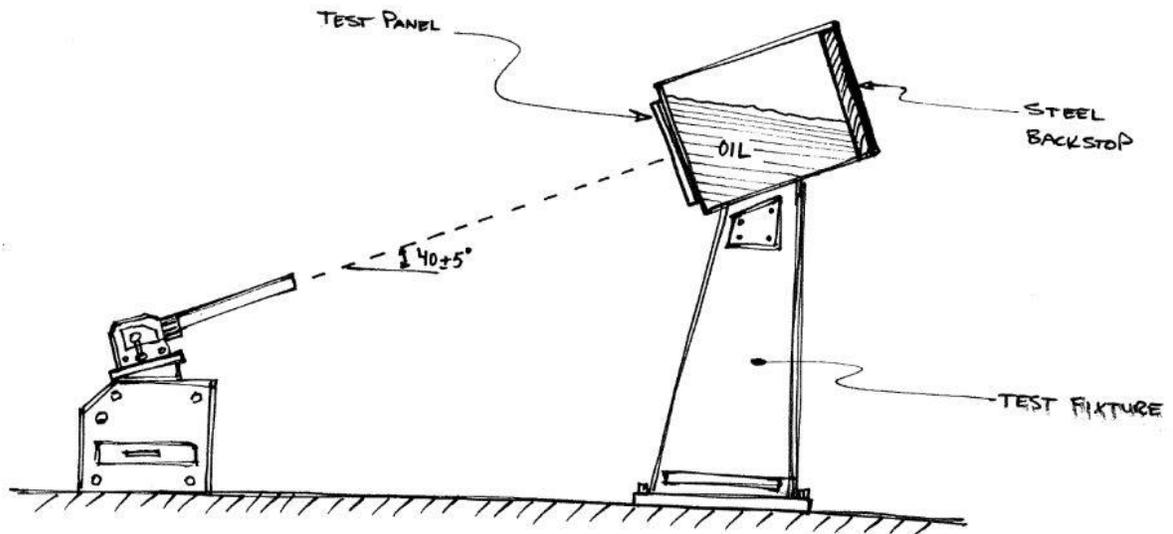
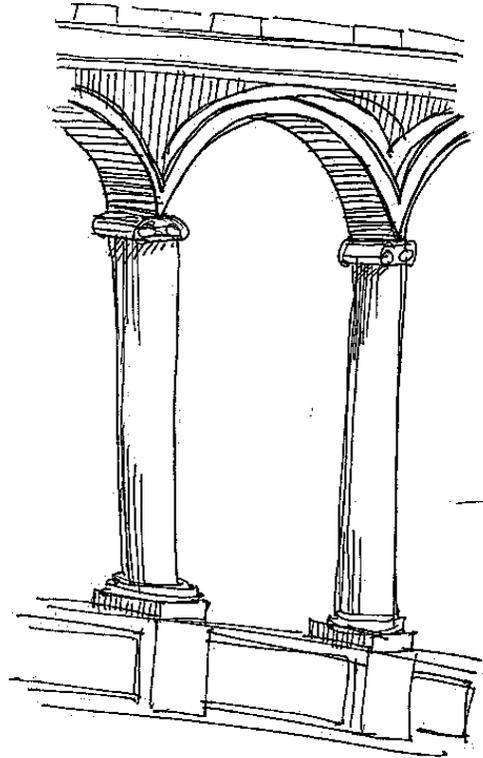
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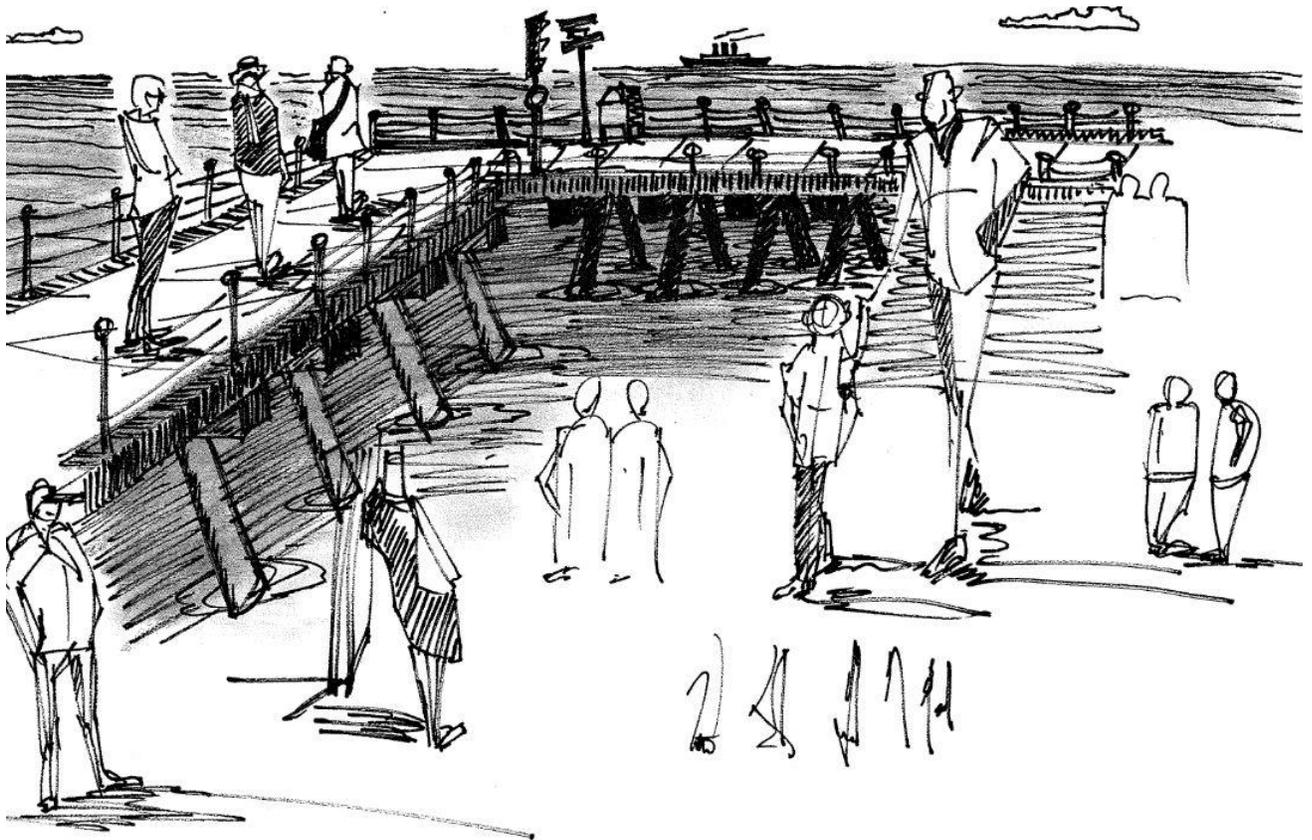
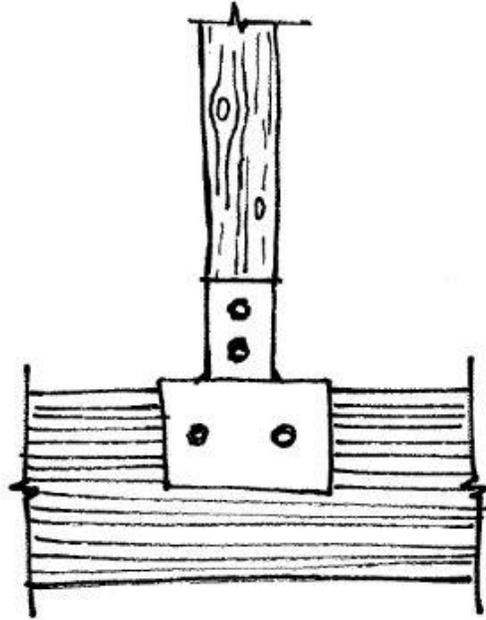
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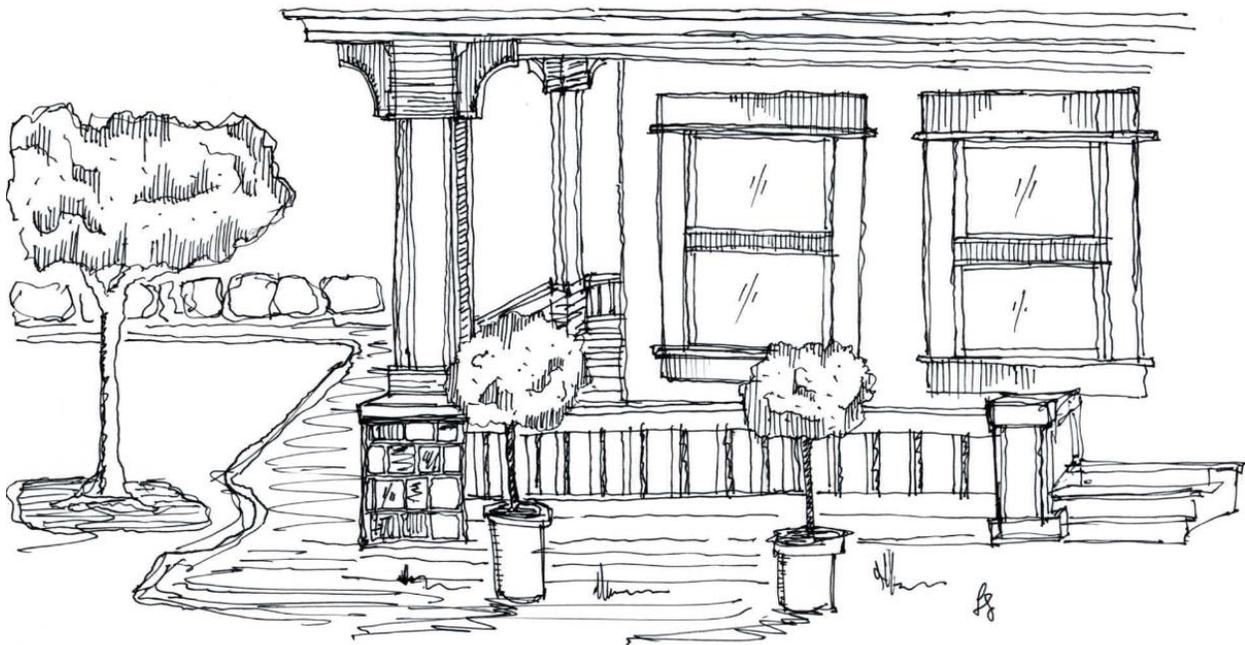
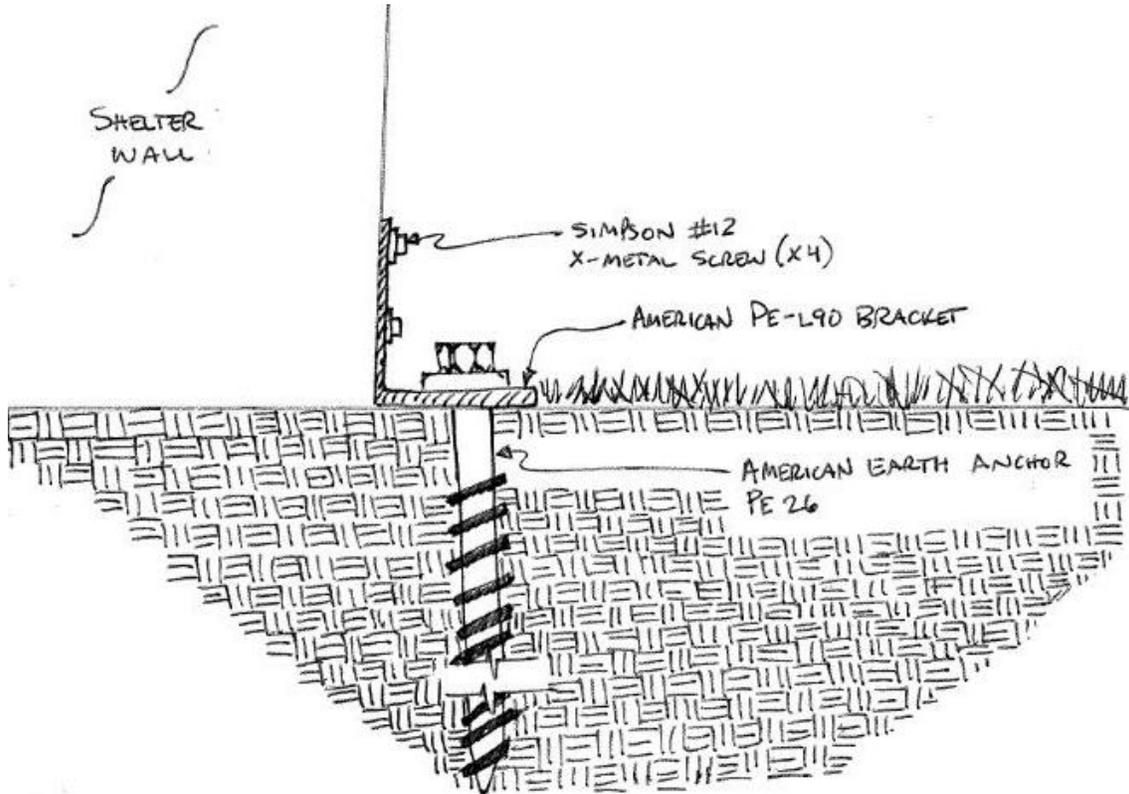
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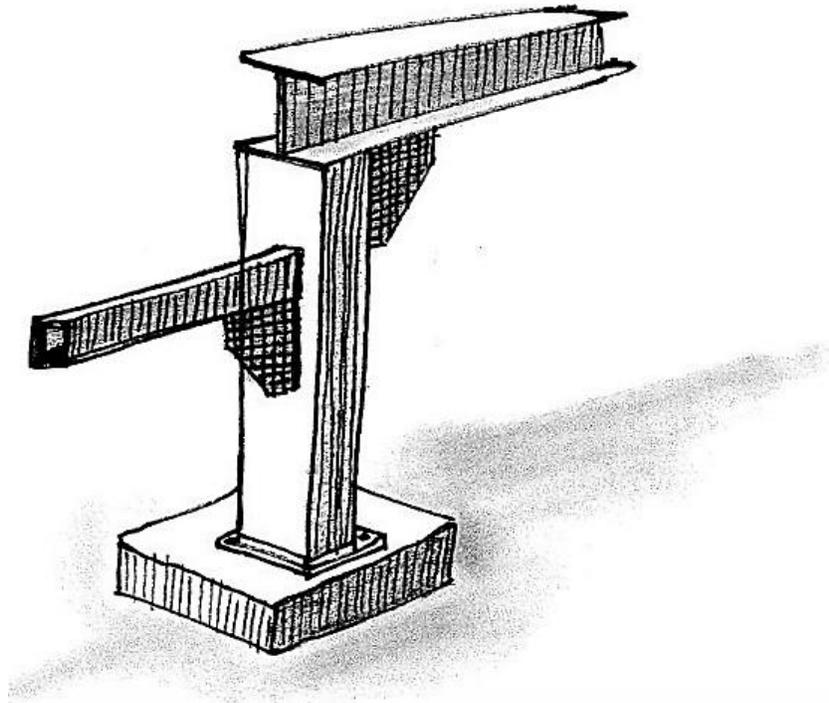


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Conclusion

There are many aspects of drawing that we haven't covered. If you want to venture into architectural sketching, drawing people, vehicles, trees, nature, animals, etc. you'll need to find drawing courses that focus on these elements. Perhaps you don't NEED to draw these things for your engineering work, but you will likely be surprised how often these abilities will be useful. Above all, any investment into your ability to communicate your idea is pure gold. You never know when you might need it.





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